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Our Ref. No. 3382-65133
For: MULTI-CHANNEL AUDIO ENCODING AND DECODING
Inventors: Thumpudi and Chen
Express Mail No. EV339202982US
Mailed: August 15, 2003

Figure 1, Prior Art

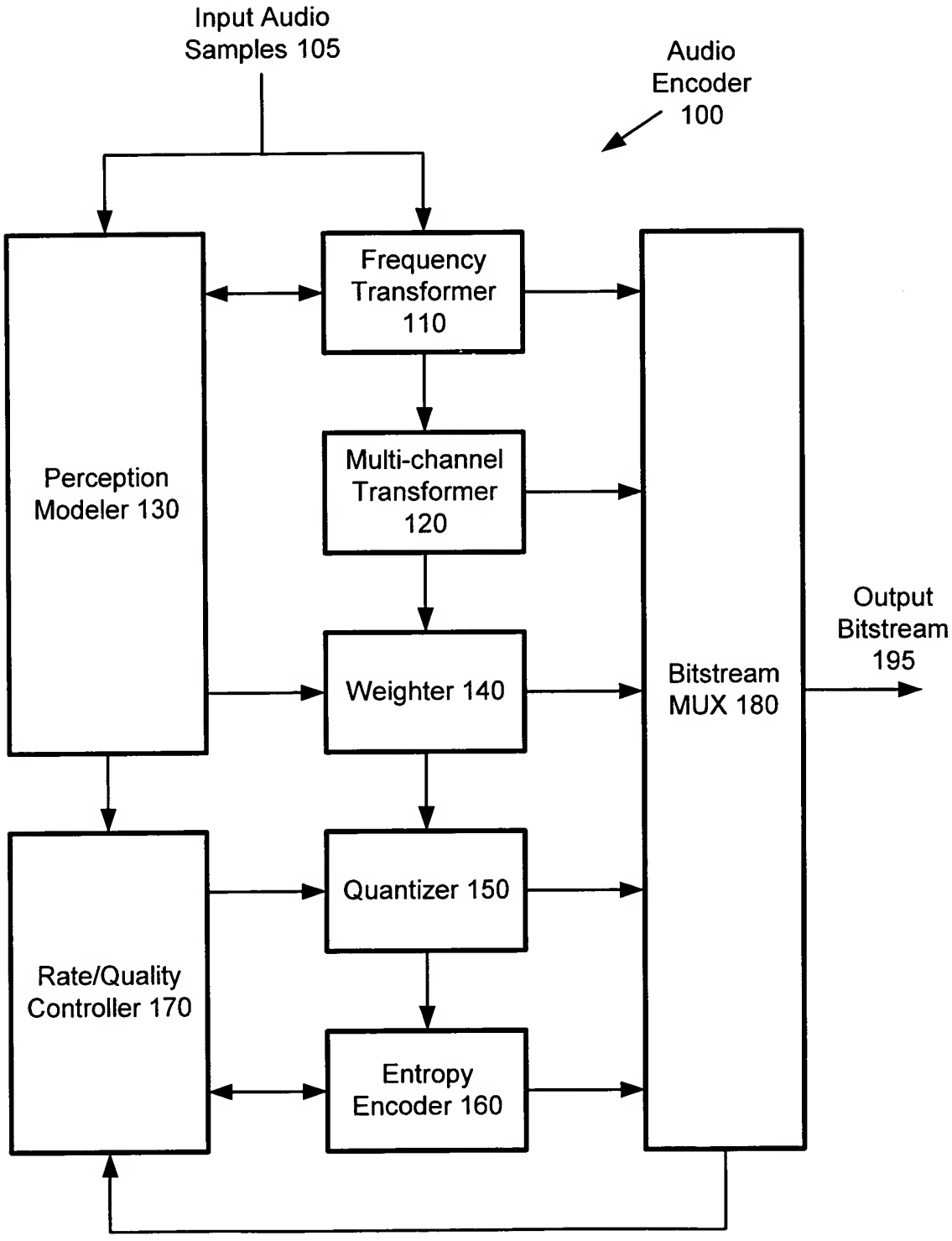

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Figure 2, Prior Art

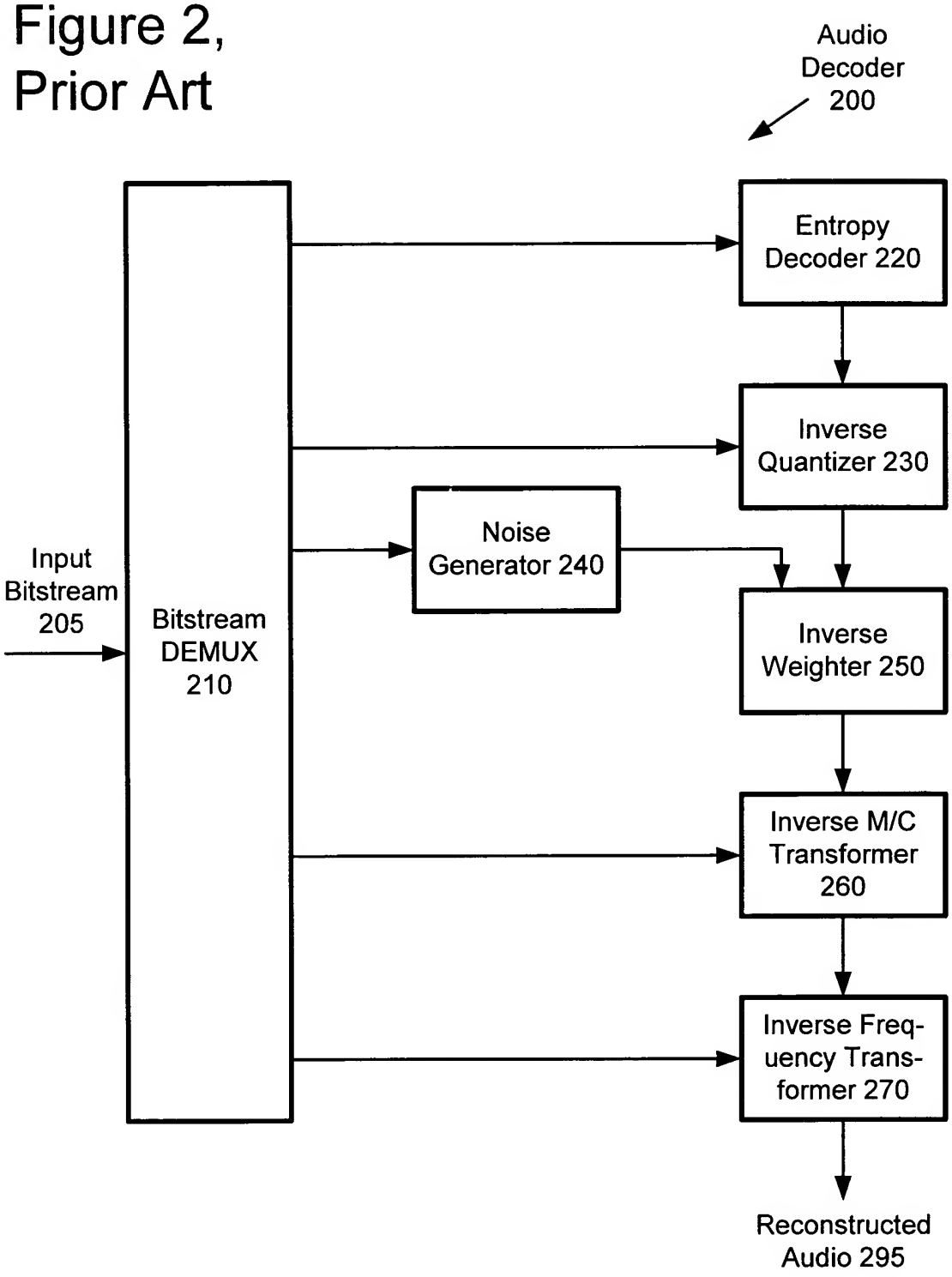


Figure 3a, Prior Art

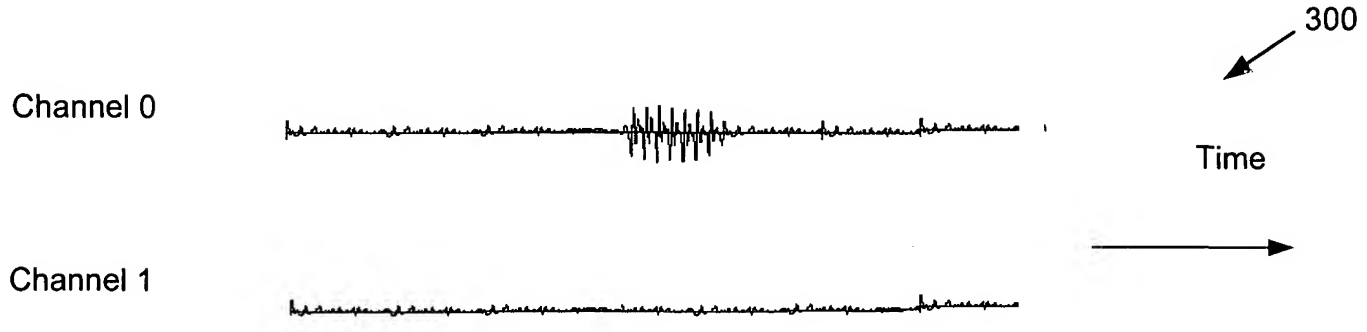
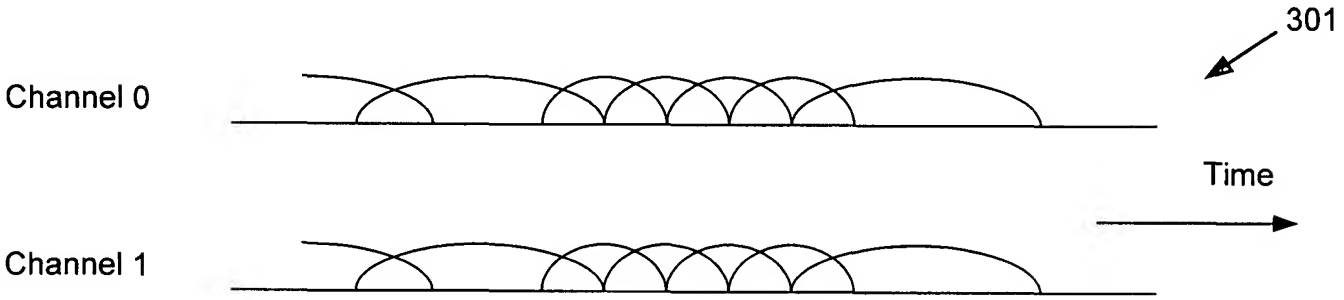


Figure 3b, Prior Art



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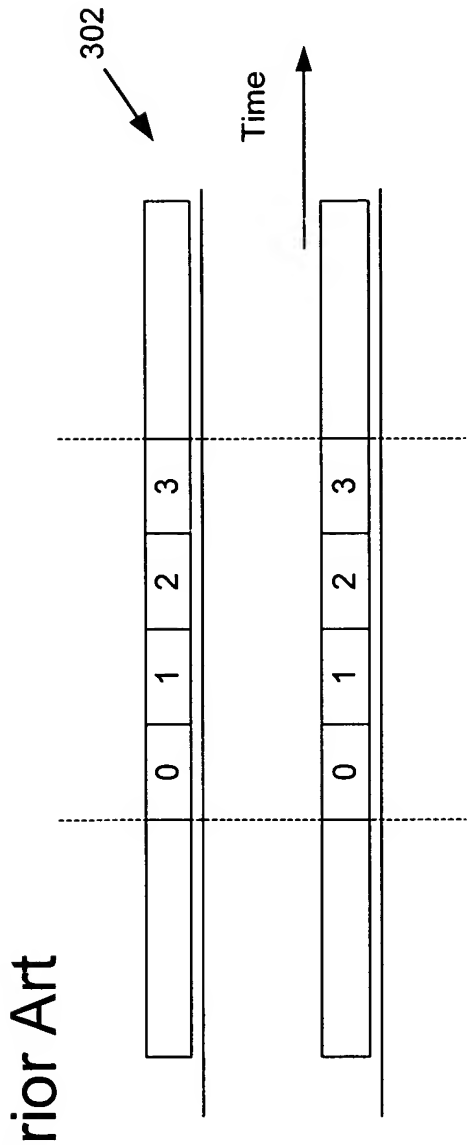

Figure 3c, Prior Art

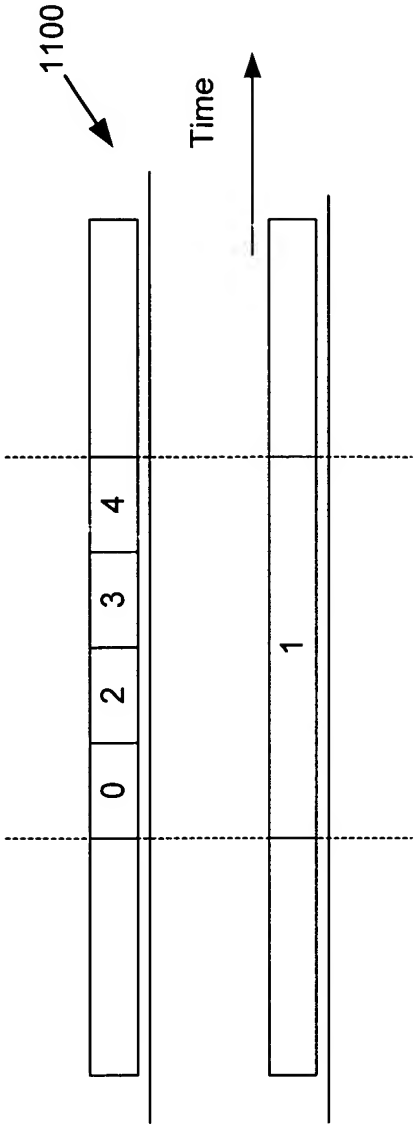

Figure 11a

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Figure 4

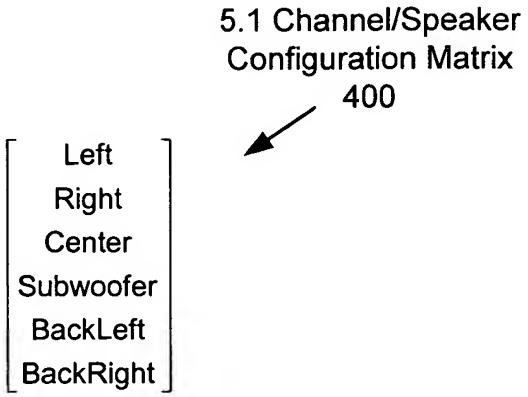

Figure 5

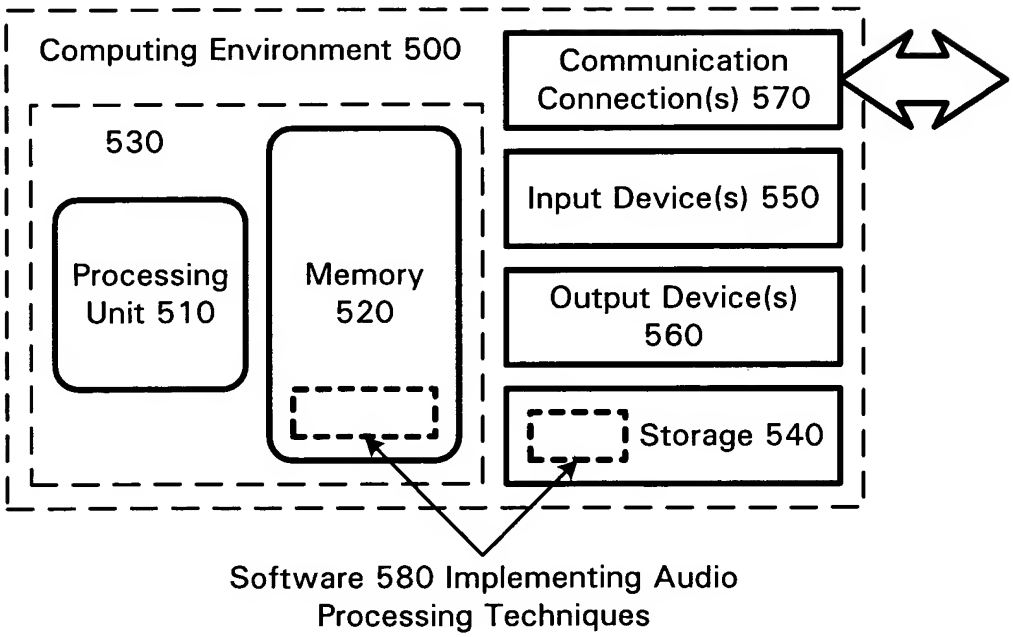

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Figure 6

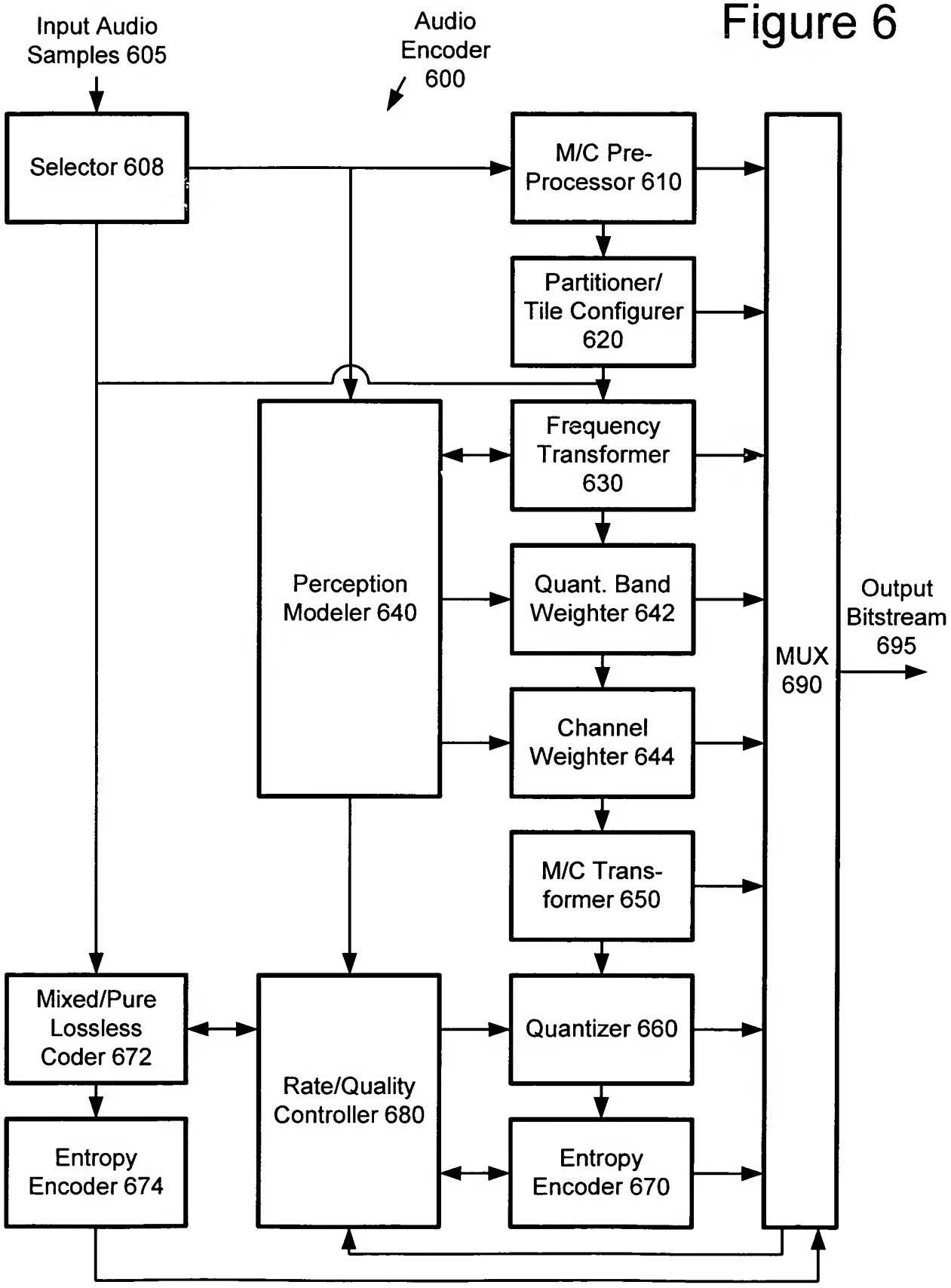

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Figure 7

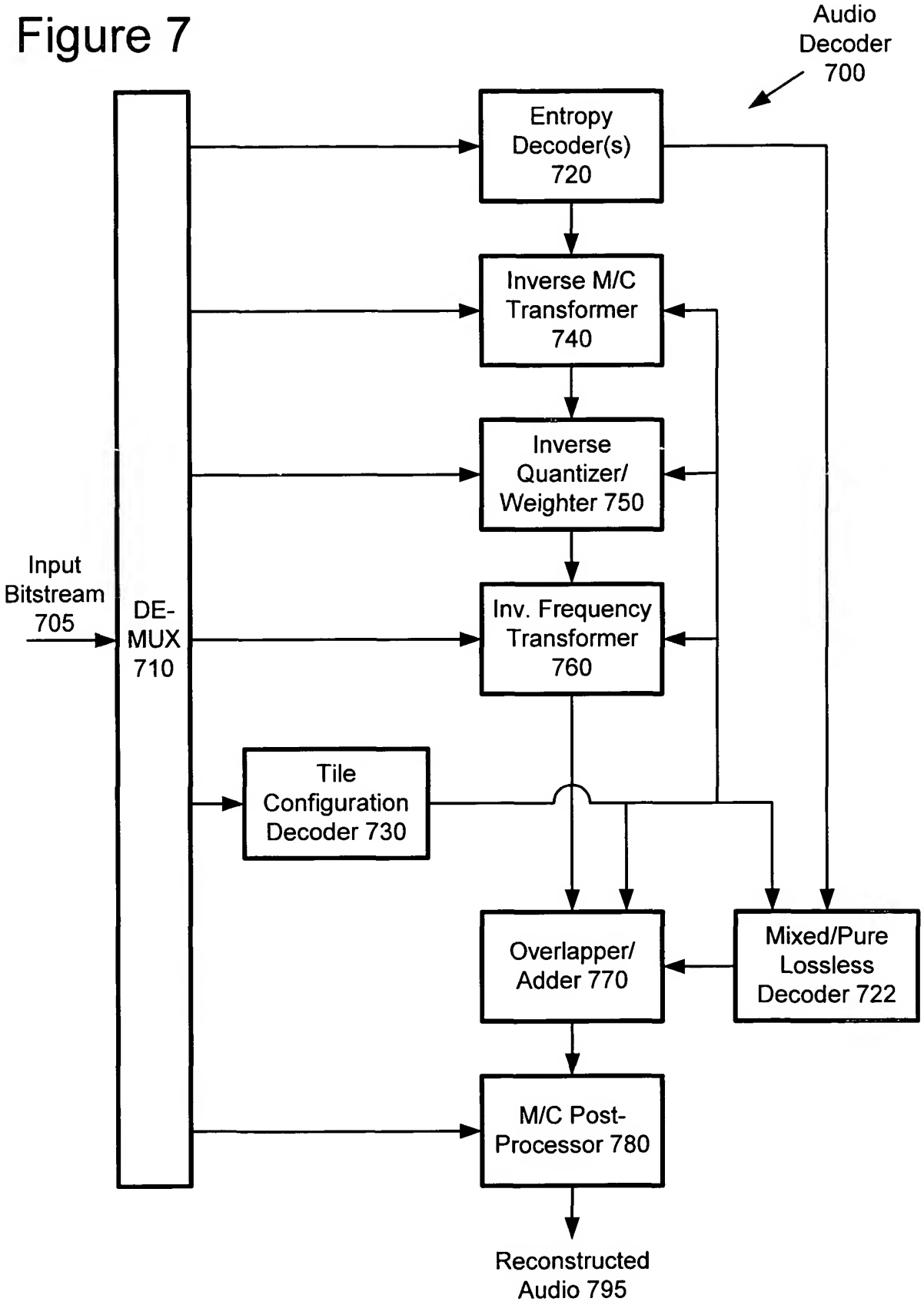

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Figure 10

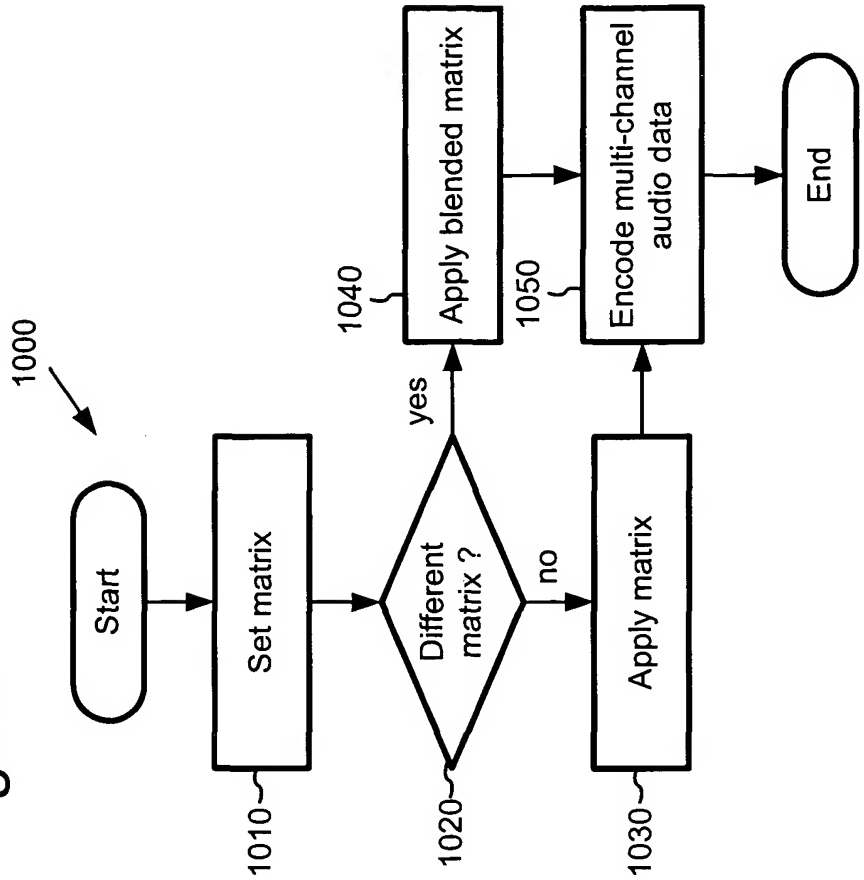

Figure 8

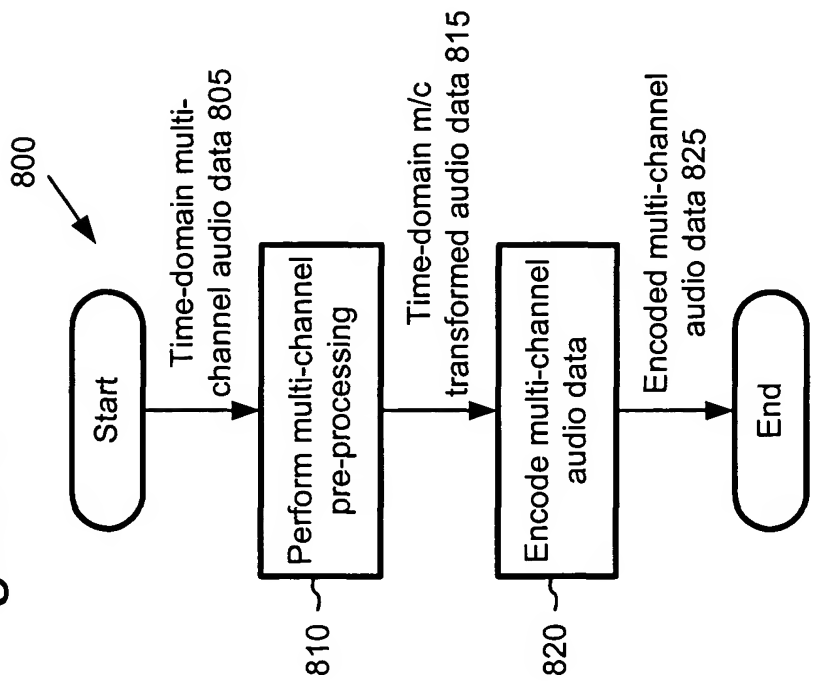

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Figure 9a

Good quality pre-processing transform matrix 900

$$A_{low} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix}$$

Figure 9b

First intermediate quality pre-processing transform matrix 901

$$A_{inter,1} = \begin{bmatrix} \left(\frac{1}{1+0.5\cdot\alpha}\right) & 0 & \left(\frac{0.5\cdot\alpha}{1+0.5\cdot\alpha}\right) & 0 & 0 & 0 \\ 0 & \left(\frac{1}{1+0.5\cdot\alpha}\right) & \left(\frac{0.5\cdot\alpha}{1+0.5\cdot\alpha}\right) & 0 & 0 & 0 \\ \left(\frac{\alpha}{1+2\alpha}\right) & \left(\frac{\alpha}{1+2\alpha}\right) & \left(\frac{1}{1+2\alpha}\right) & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & \left(\frac{1}{1+\alpha}\right) & \left(\frac{\alpha}{1+\alpha}\right) \\ 0 & 0 & 0 & 0 & \left(\frac{\alpha}{1+\alpha}\right) & \left(\frac{1}{1+\alpha}\right) \end{bmatrix}$$

Figure 9c

First poor quality pre-processing transform matrix 902

$$A_{high,1} = \begin{bmatrix} \left(\frac{1}{1.5}\right) & 0 & \left(\frac{0.5}{1.5}\right) & 0 & 0 & 0 \\ 0 & \left(\frac{1}{1.5}\right) & \left(\frac{0.5}{1.5}\right) & 0 & 0 & 0 \\ \left(\frac{1}{3}\right) & \left(\frac{1}{3}\right) & \left(\frac{1}{3}\right) & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0.5 & 0.5 \\ 0 & 0 & 0 & 0 & 0.5 & 0.5 \end{bmatrix}$$

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Figure 9d

Second intermediate quality pre-processing transform matrix 903

$$A_{inter,2} = \begin{bmatrix} \left(\frac{1}{1+0.5\cdot\alpha}\right) & 0 & \left(\frac{0.5\cdot\alpha}{1+0.5\cdot\alpha}\right) & 0 & 0 & 0 \\ 0 & \left(\frac{1}{1+0.5\cdot\alpha}\right) & \left(\frac{0.5\cdot\alpha}{1+0.5\cdot\alpha}\right) & 0 & 0 & 0 \\ 0.5\cdot\alpha & 0.5\cdot\alpha & 1-\alpha & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & \left(\frac{1}{1+\alpha}\right) & \left(\frac{\alpha}{1+\alpha}\right) \\ 0 & 0 & 0 & 0 & \left(\frac{\alpha}{1+\alpha}\right) & \left(\frac{1}{1+\alpha}\right) \end{bmatrix}$$

Figure 9e

Second poor quality pre-processing transform matrix 904

$$A_{high,2} = \begin{bmatrix} \left(\frac{1}{1.5}\right) & 0 & \left(\frac{0.5}{1.5}\right) & 0 & 0 & 0 \\ 0 & \left(\frac{1}{1.5}\right) & \left(\frac{0.5}{1.5}\right) & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0.5 & 0.5 \\ 0 & 0 & 0 & 0 & 0.5 & 0.5 \end{bmatrix}$$

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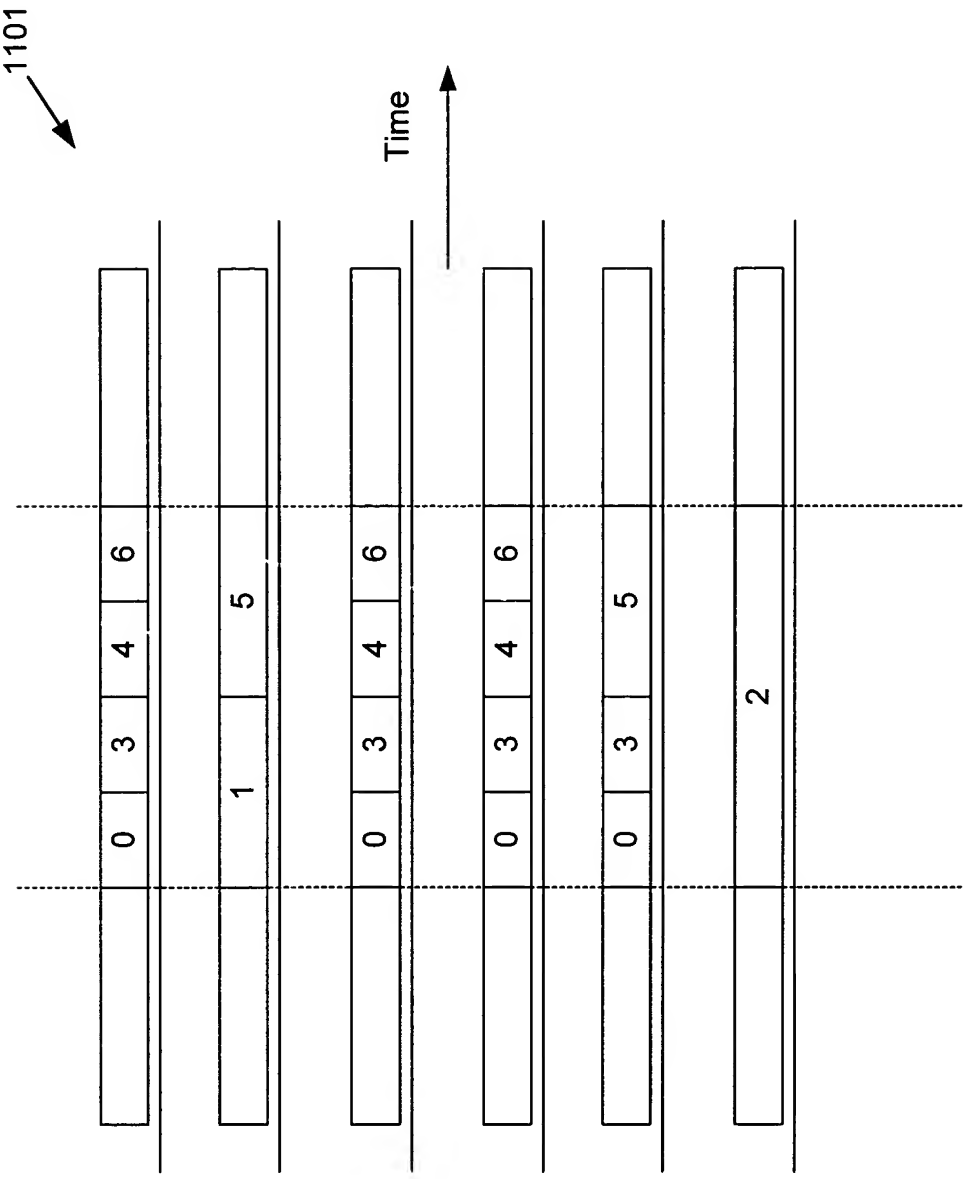

Figure 11b

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Figure 15

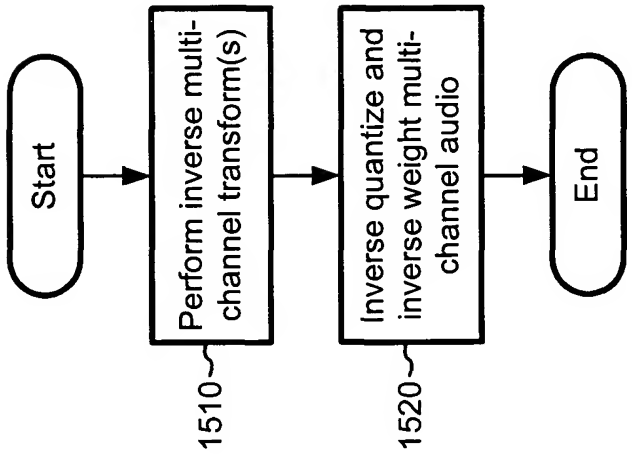

Figure 14

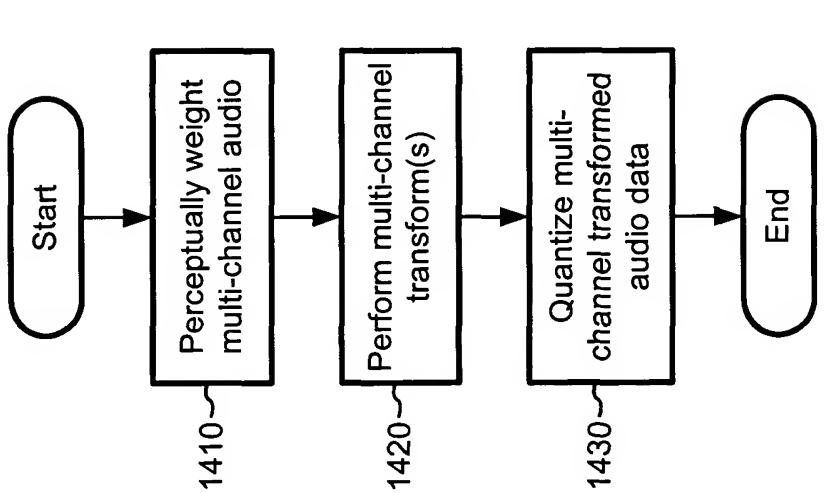

Figure 12

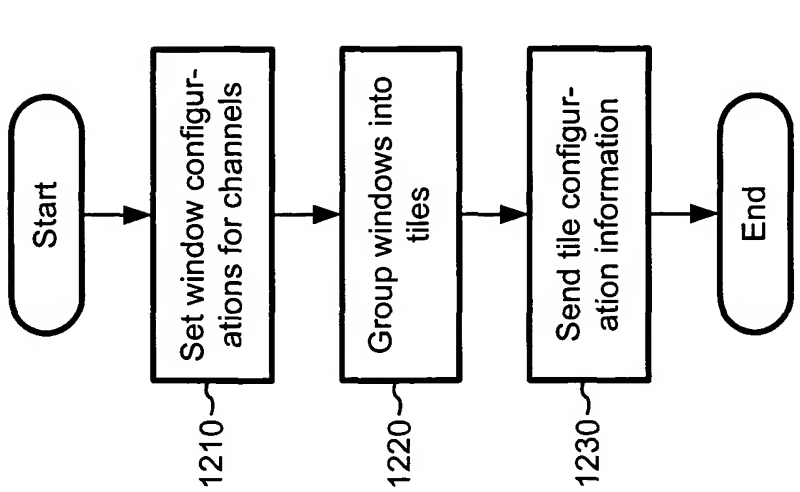

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Figure 13

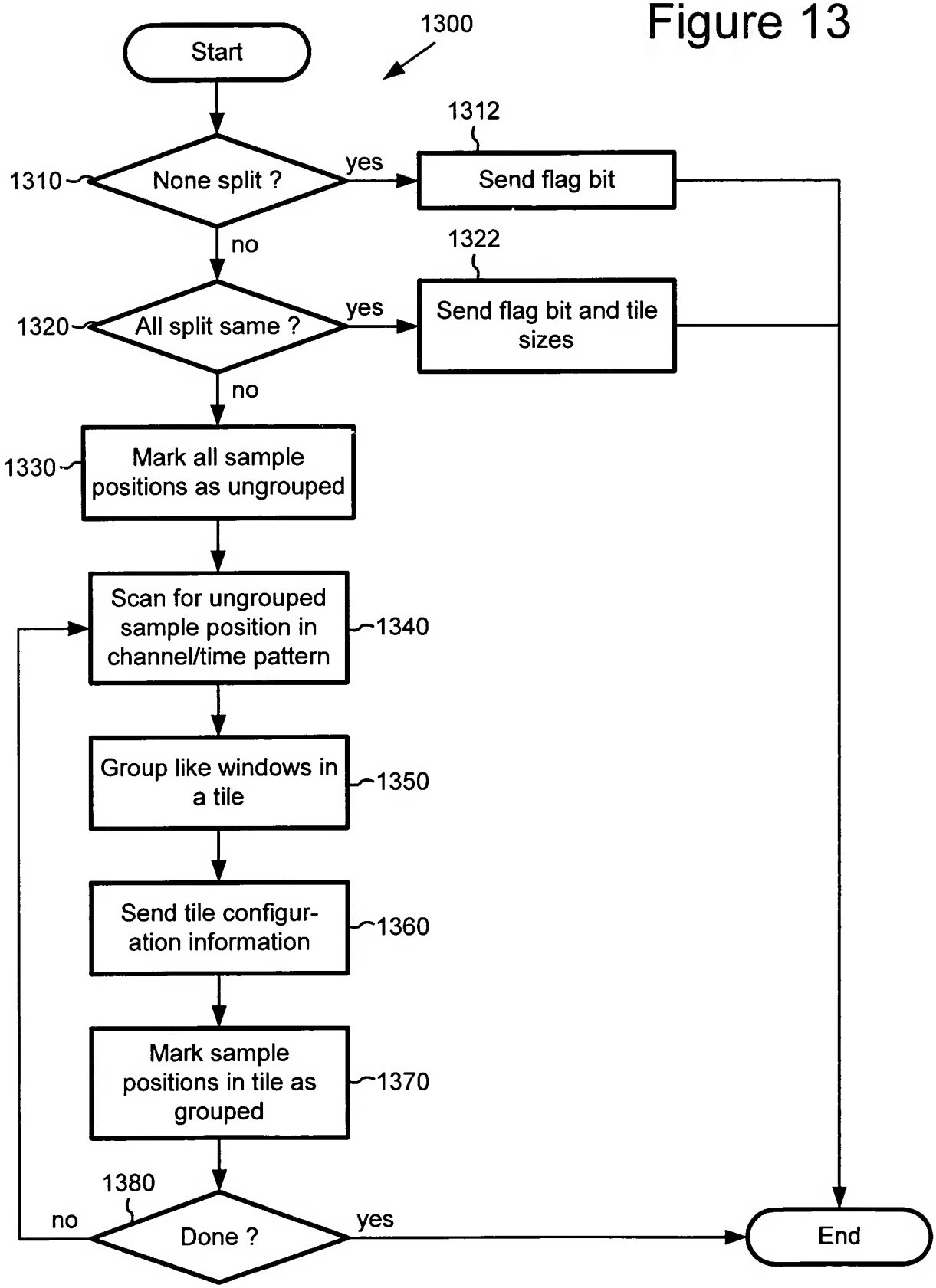

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Figure 16

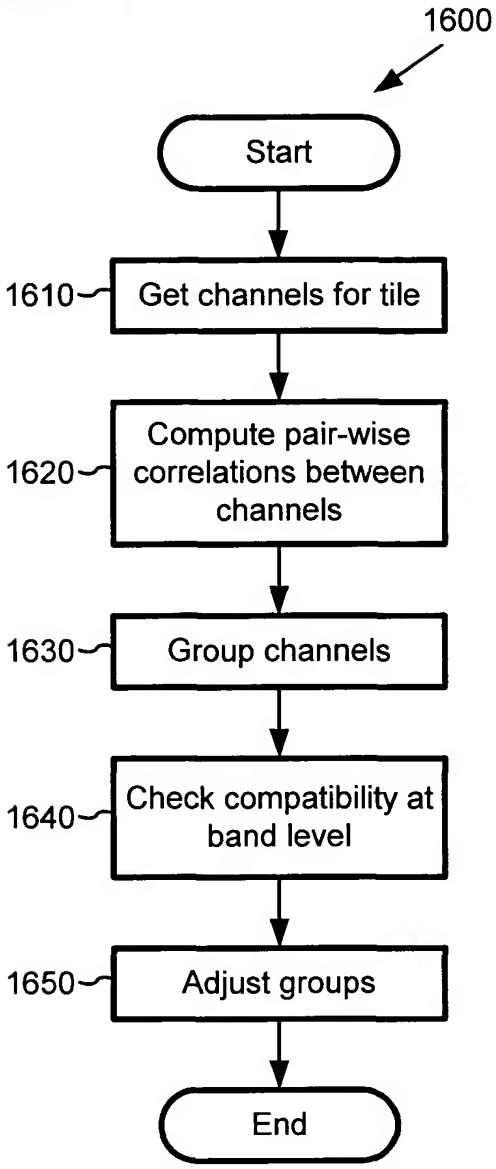

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Figure 17

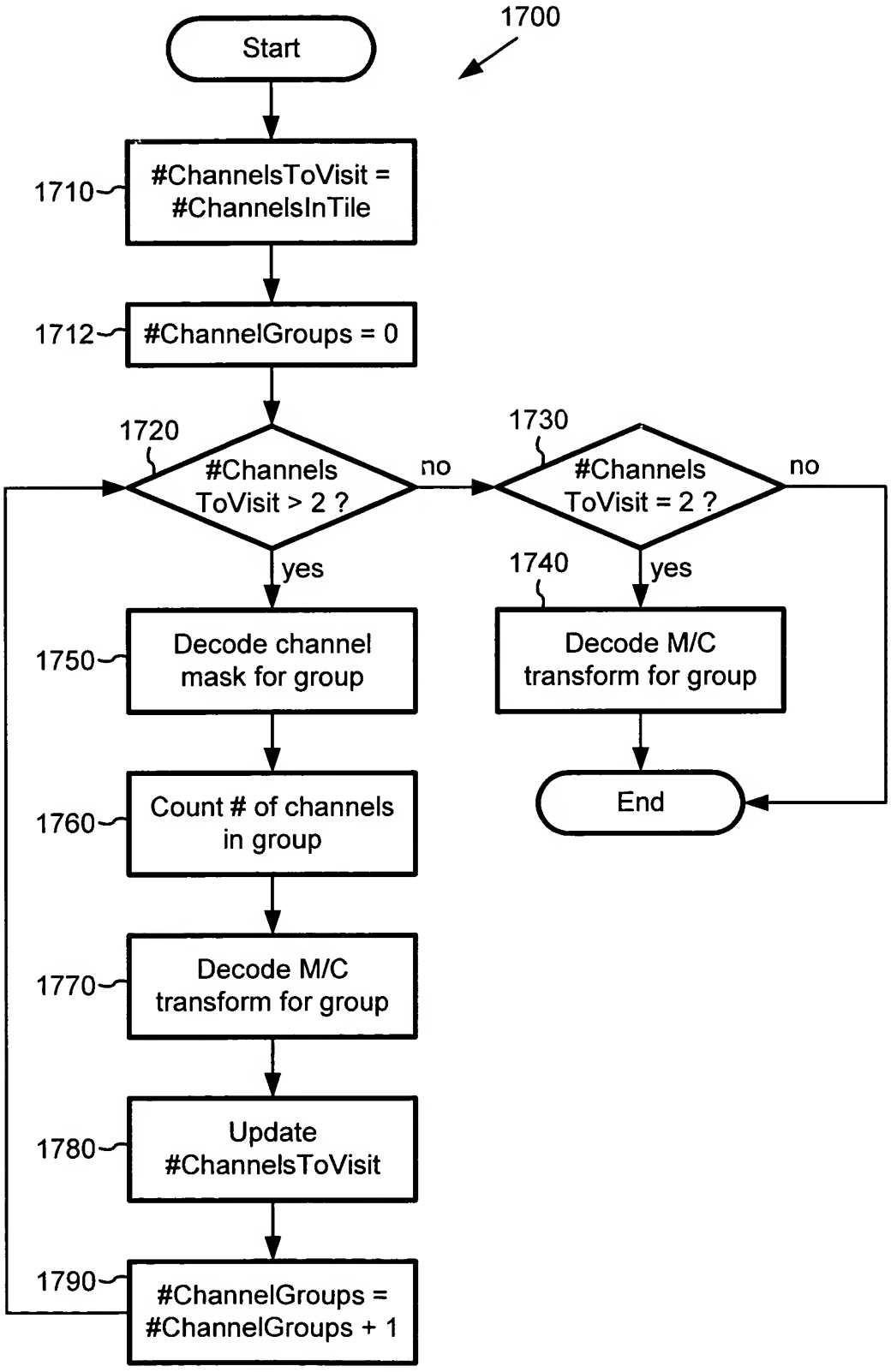

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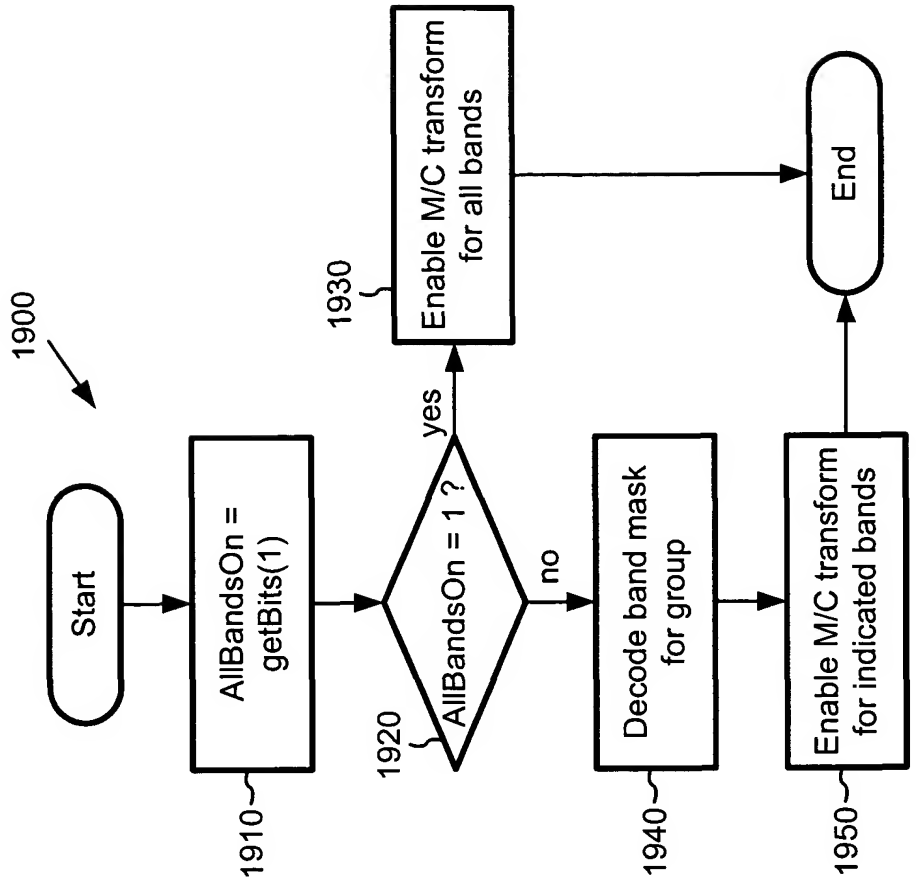
Figure 19



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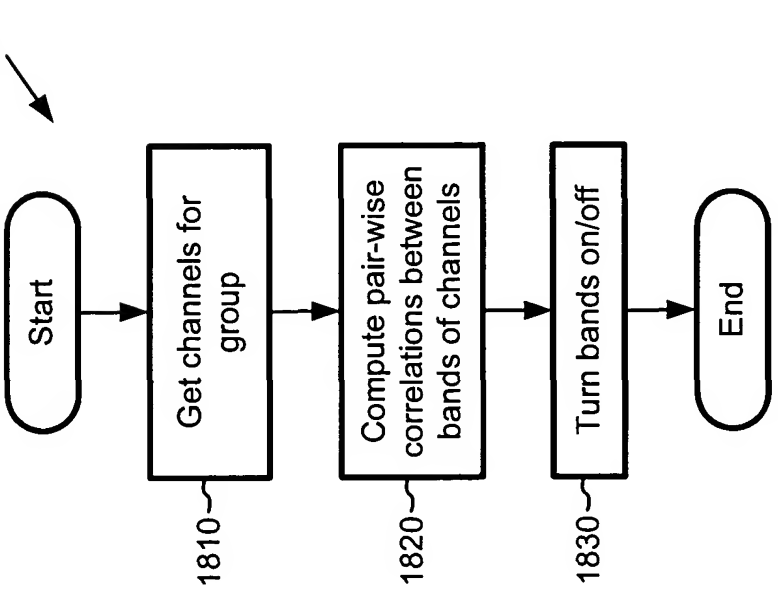

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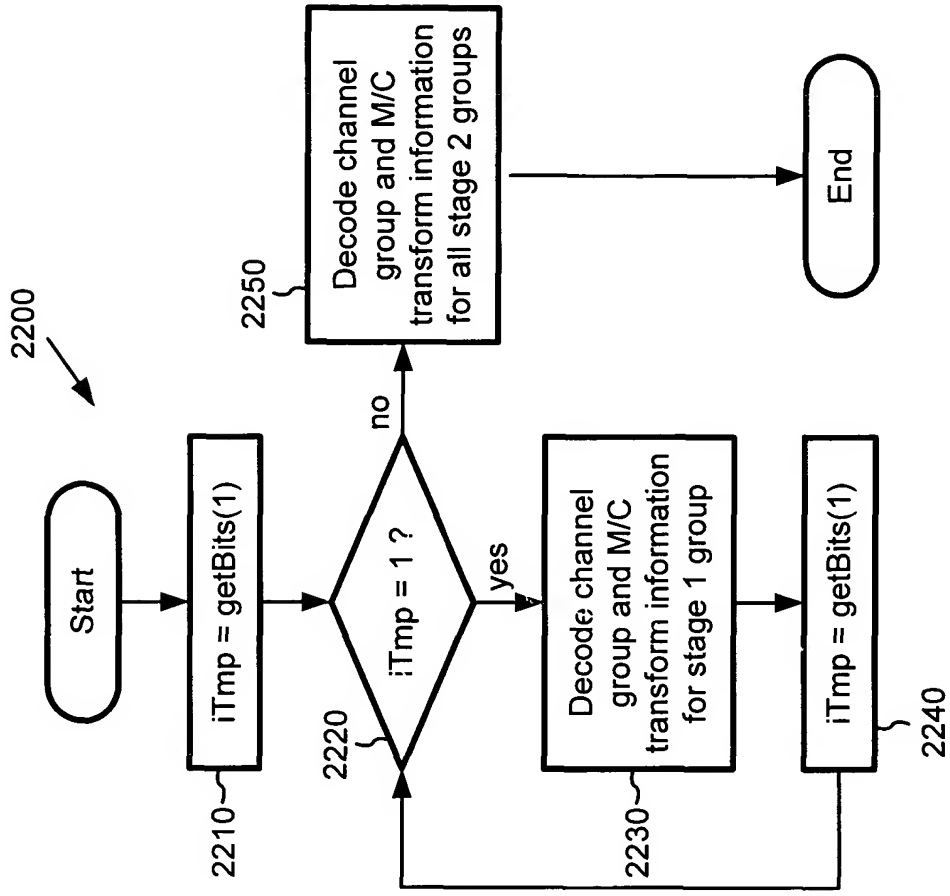
Figure 22



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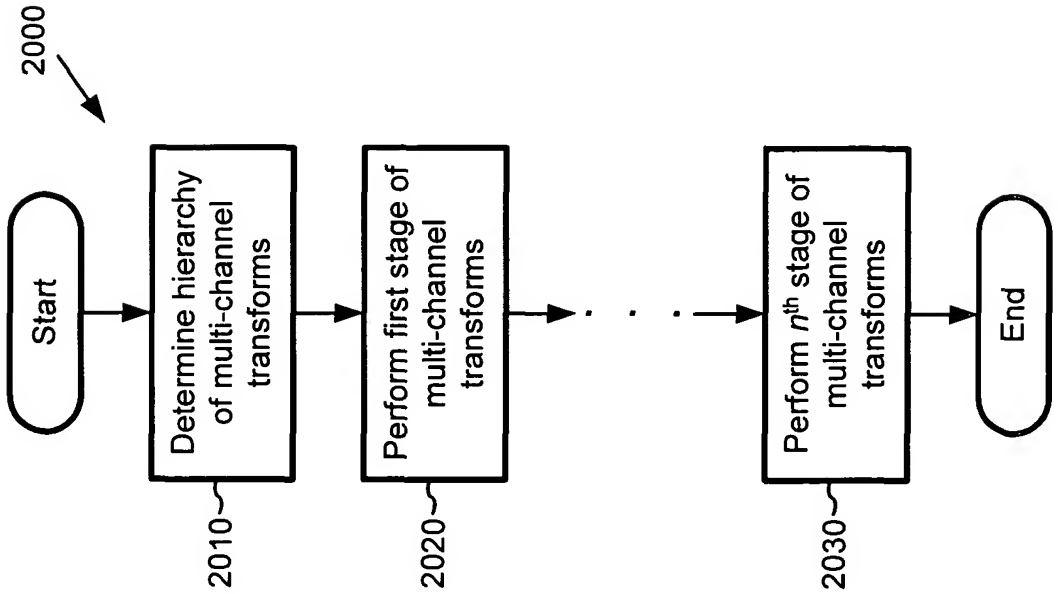

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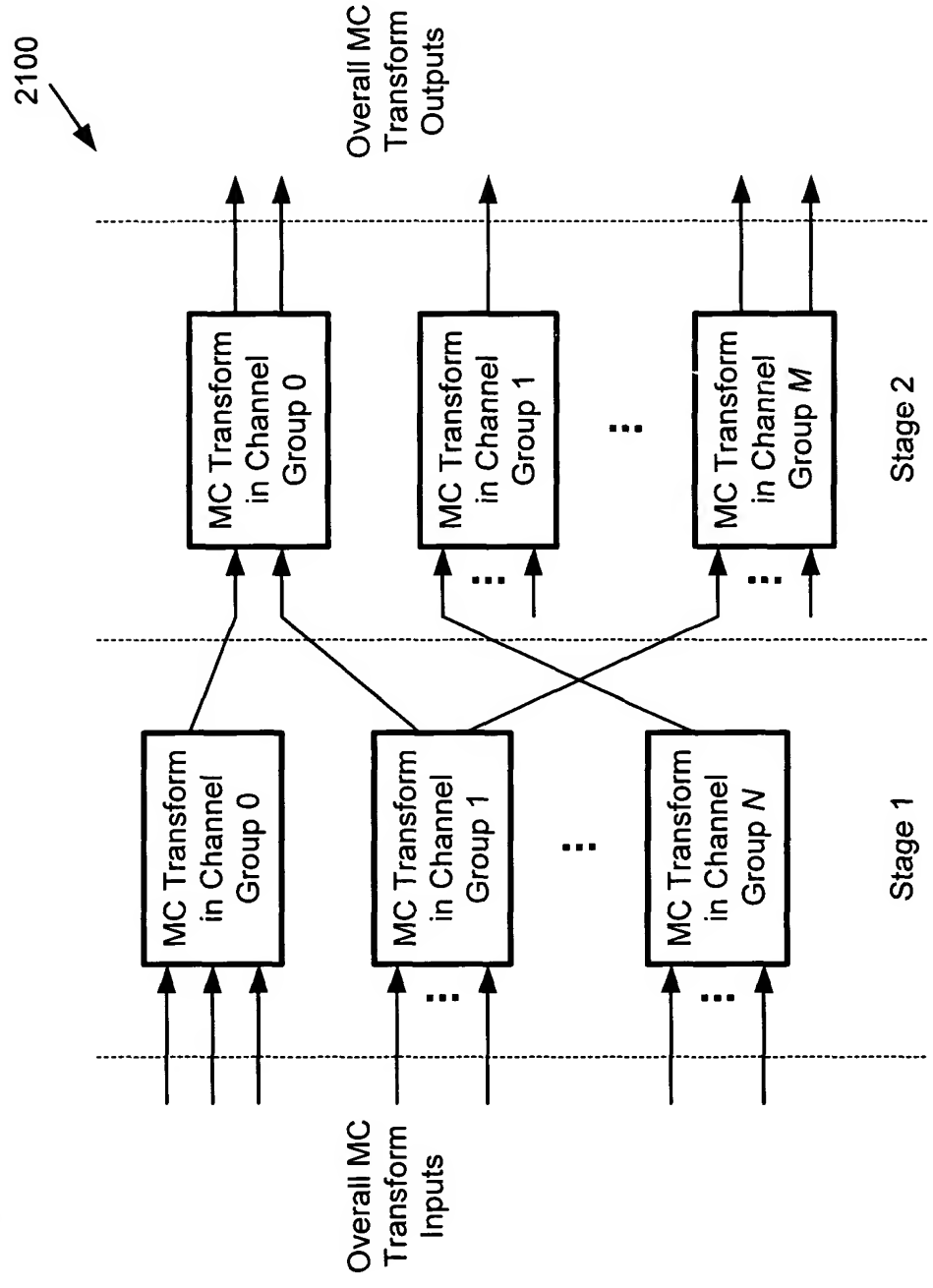

Figure 21

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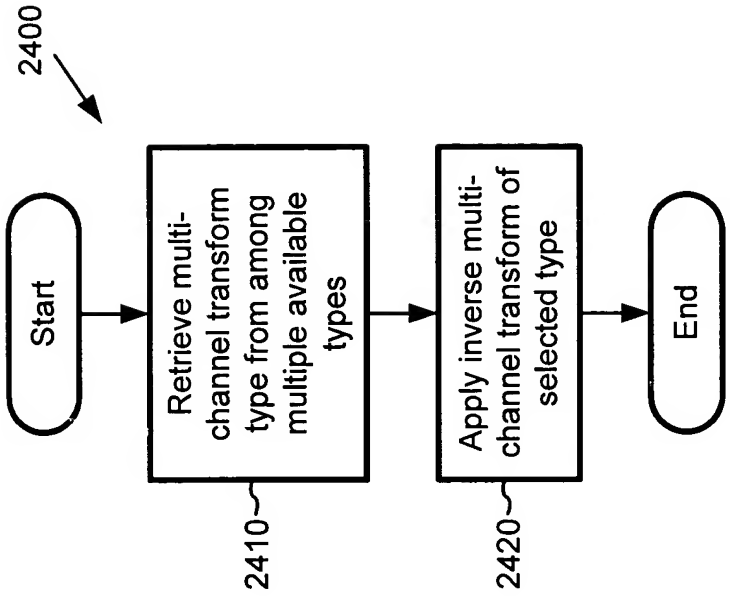
Figure 24



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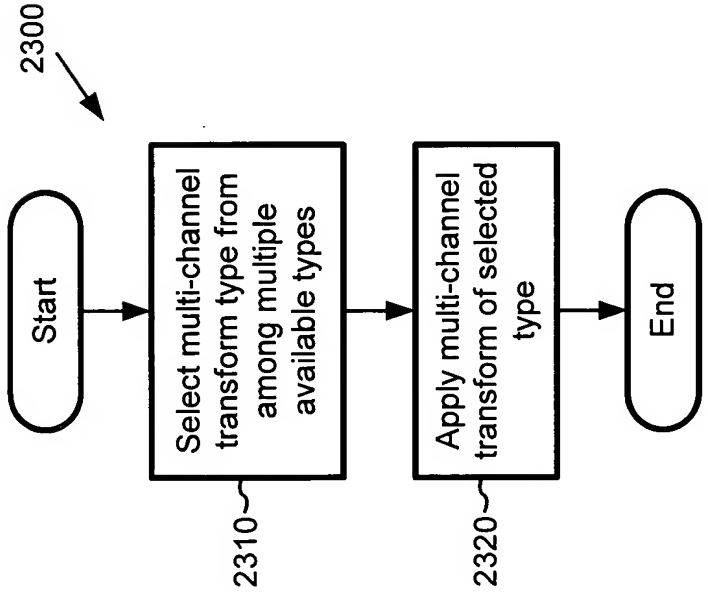

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Figure 25

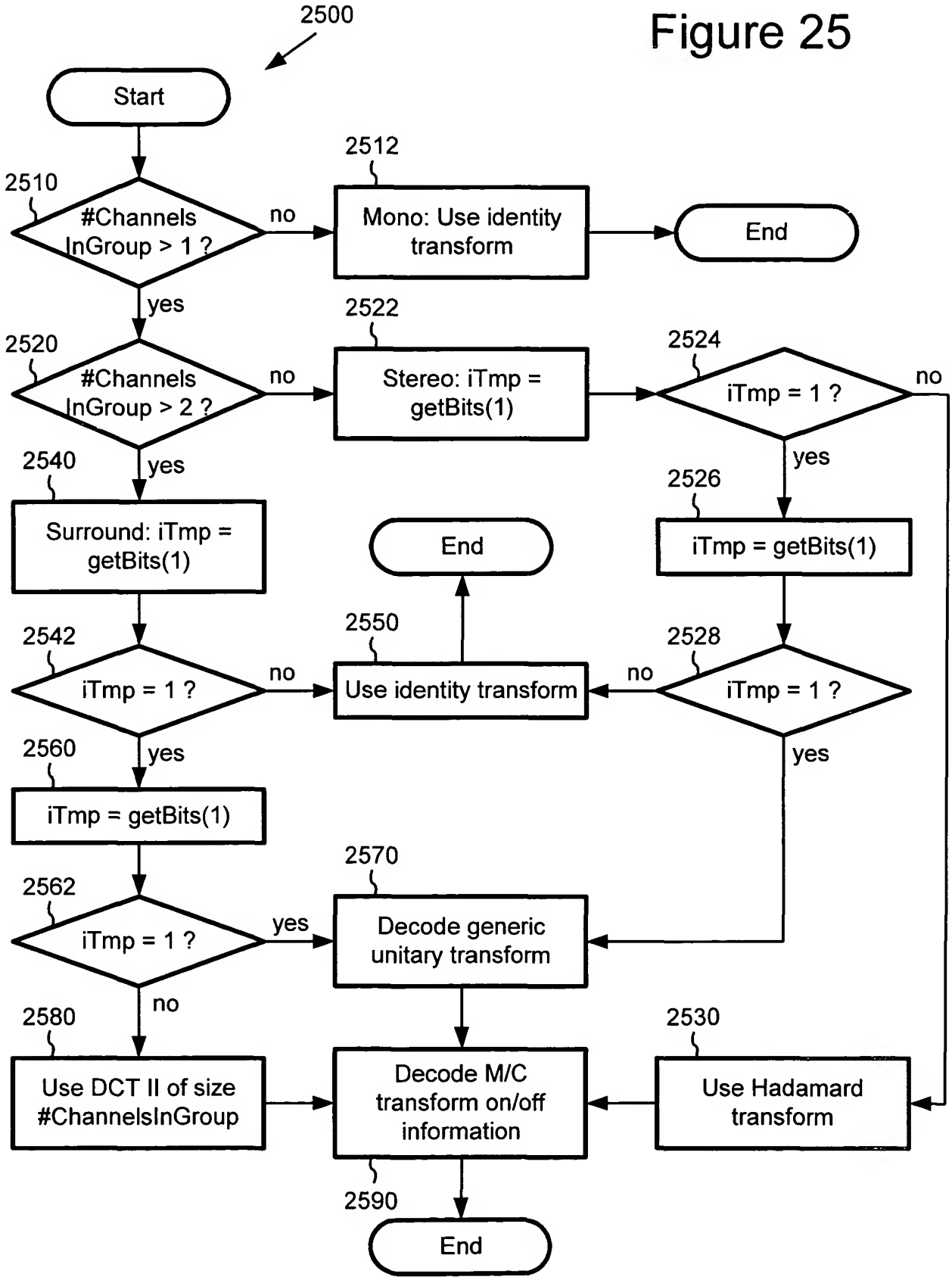

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Figure 28

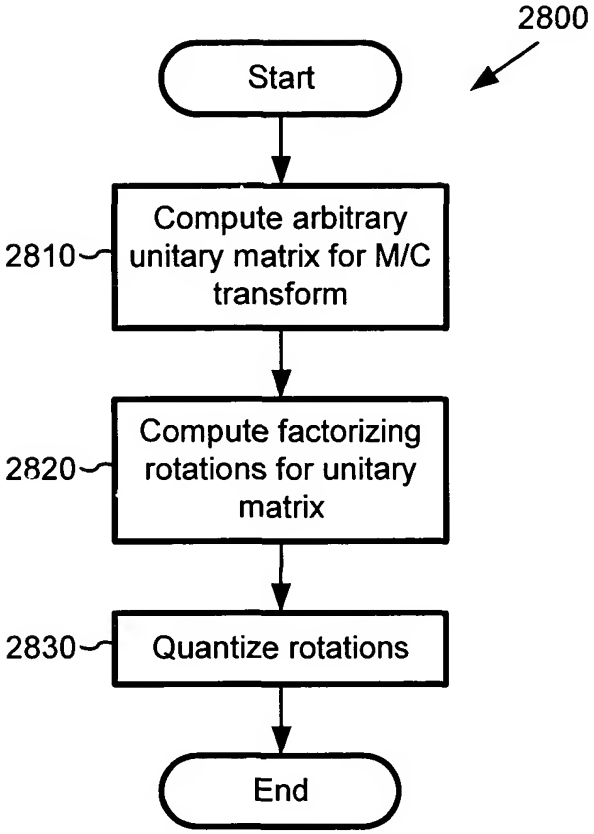

Figure 26

2600

$$\begin{bmatrix} 1 & 0 & 0 & 0 & \cdots & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & \cdots & 0 & 0 & 0 & 0 \\ 0 & 0 & \cos\omega_k & 0 & \cdots & \sin\omega_k & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & \cdots & 0 & 0 & 0 & 0 \\ \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots \\ 0 & 0 & -\sin\omega_k & 0 & \cdots & \cos\omega_k & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & \cdots & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & \cdots & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & \cdots & 0 & 0 & 0 & 1 \end{bmatrix}$$

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Figure 27a

$$\Theta_1 = \begin{bmatrix} \cos\varpi_1 & \sin\varpi_1 & 0 & 0 & 0 & 0 & 0 & \cdots & 0 \\ -\sin\varpi_1 & \cos\varpi_1 & 0 & 0 & 0 & 0 & 0 & \cdots & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & \cdots & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & \cdots & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & \cdots & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & \cdots & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & \cdots & 0 \\ \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & \cdots & 1 \end{bmatrix}$$

2700

Figure 27b

$$\Theta_2 = \begin{bmatrix} \cos\varpi_2 & 0 & \sin\varpi_2 & 0 & 0 & 0 & 0 & \cdots & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 & \cdots & 0 \\ -\sin\varpi_2 & 0 & \cos\varpi_2 & 0 & 0 & 0 & 0 & \cdots & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & \cdots & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & \cdots & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & \cdots & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & \cdots & 0 \\ \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & \cdots & 1 \end{bmatrix}$$

2701

Figure 27c

$$\Theta_3 = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & \cdots & 0 \\ 0 & \cos\varpi_3 & \sin\varpi_3 & 0 & 0 & 0 & 0 & \cdots & 0 \\ 0 & -\sin\varpi_3 & \cos\varpi_3 & 0 & 0 & 0 & 0 & \cdots & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & \cdots & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & \cdots & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & \cdots & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & \cdots & 0 \\ \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & \cdots & 1 \end{bmatrix}$$

2702

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Inventors: Thumpudi and Chen
Express Mail No. EV339202982US
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Figure 29

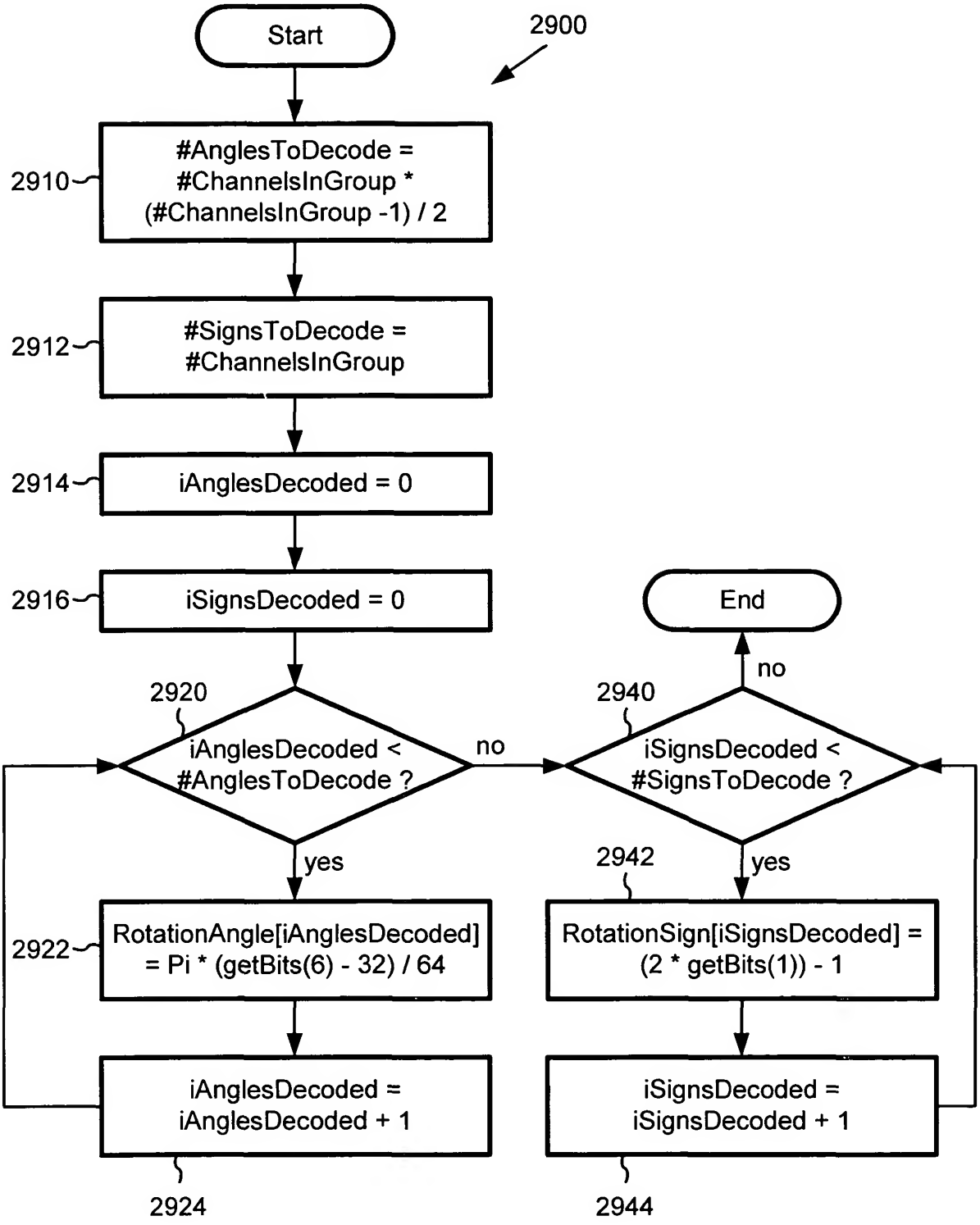

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Figure 31

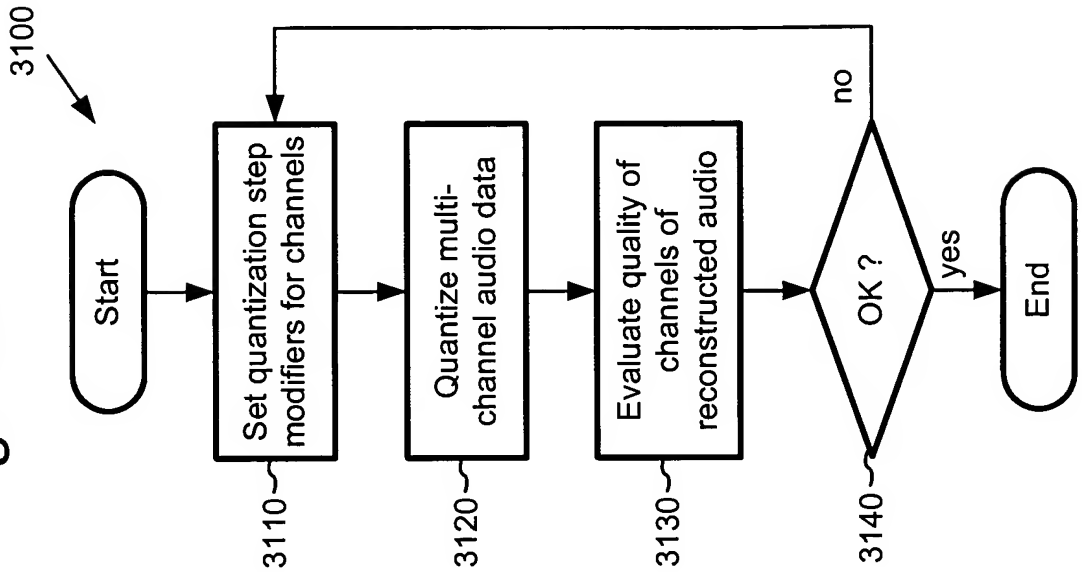

Figure 30

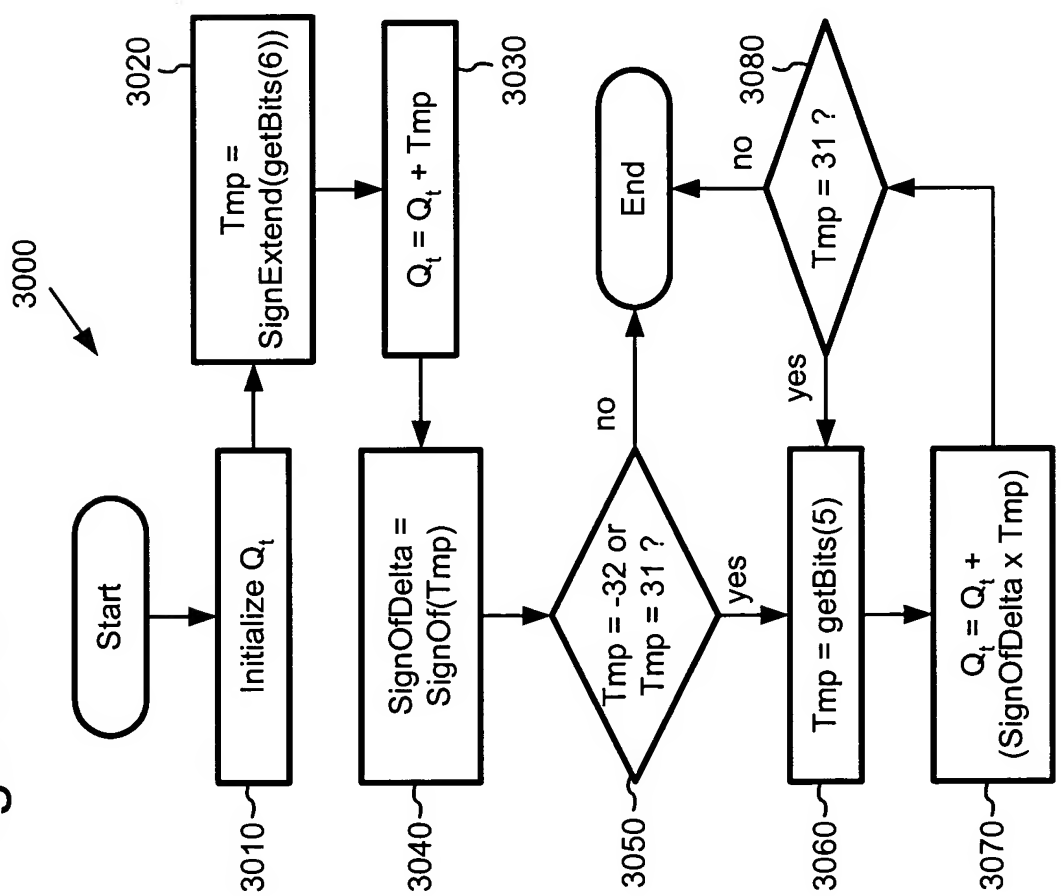

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Figure 32

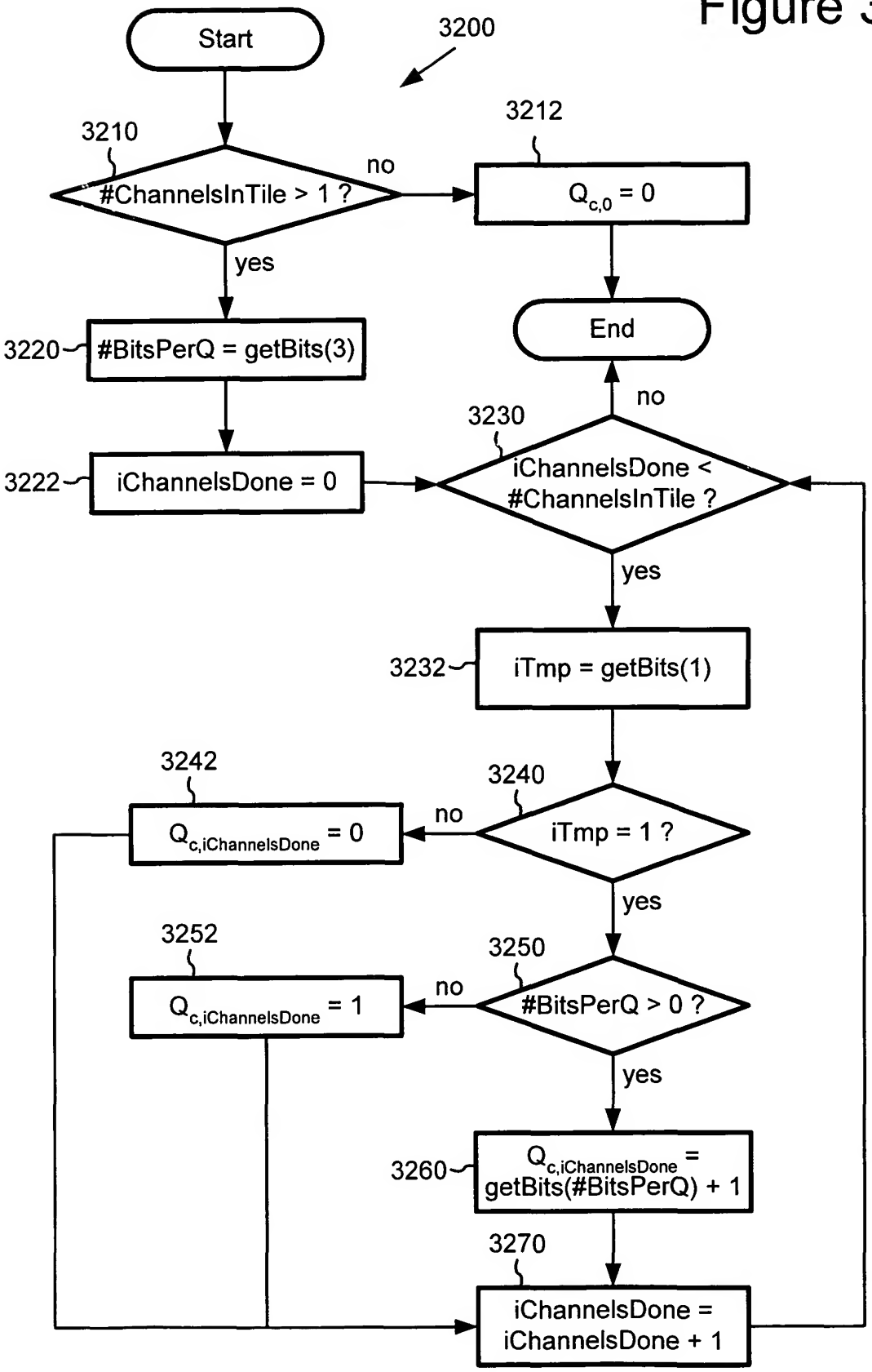

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Figure 34

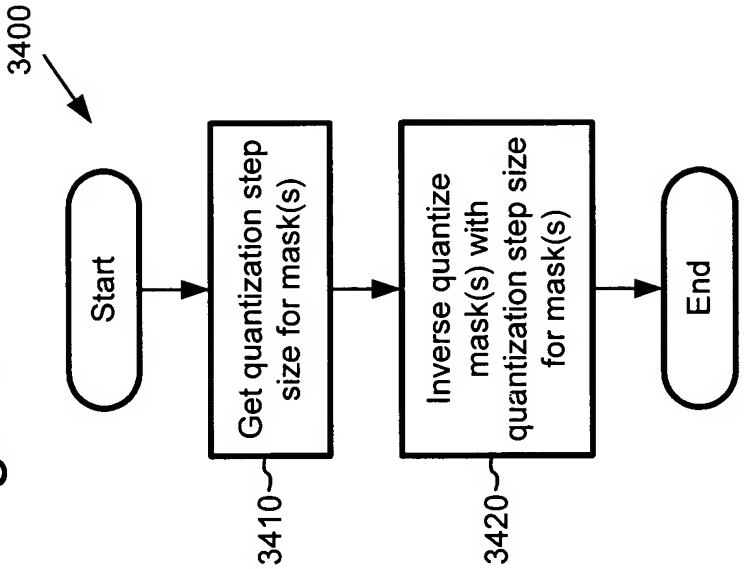
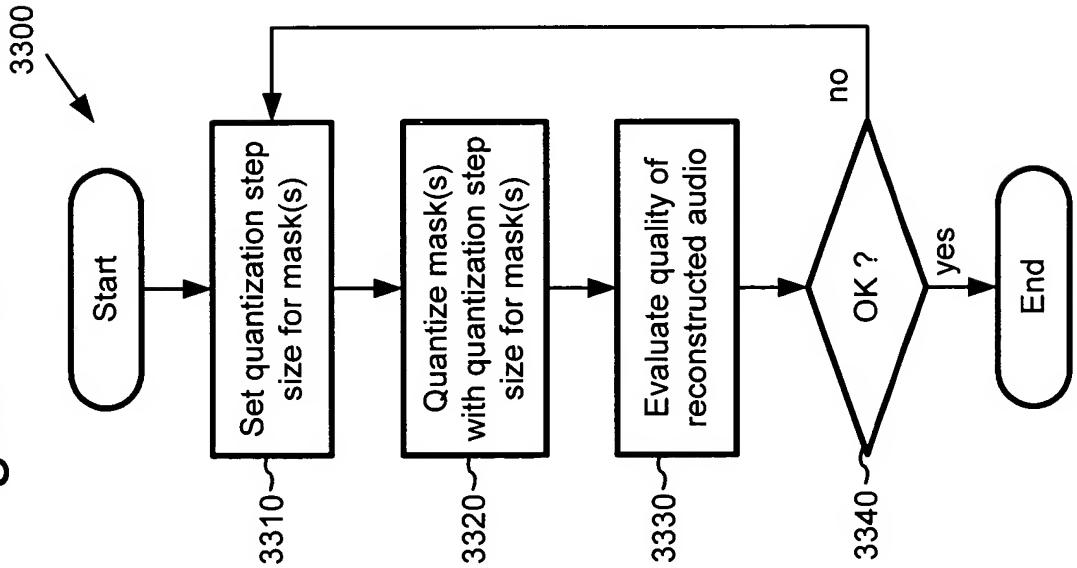


Figure 33



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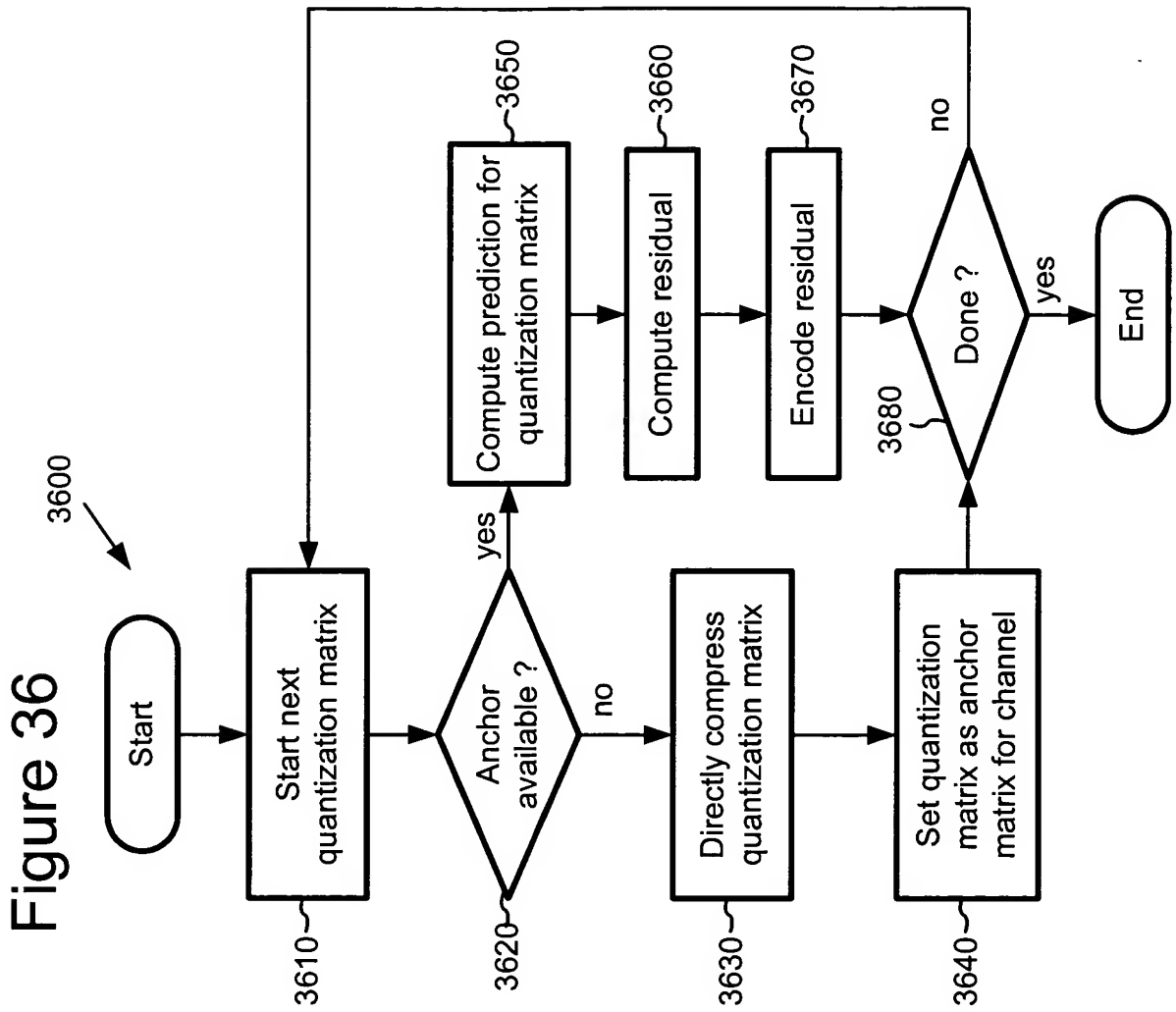

Figure 36

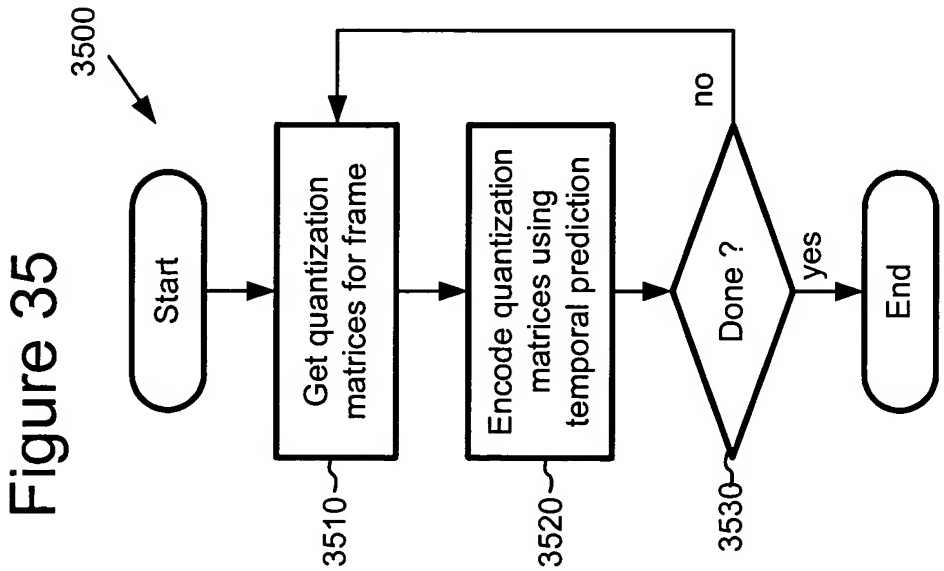

Figure 35

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Figure 37

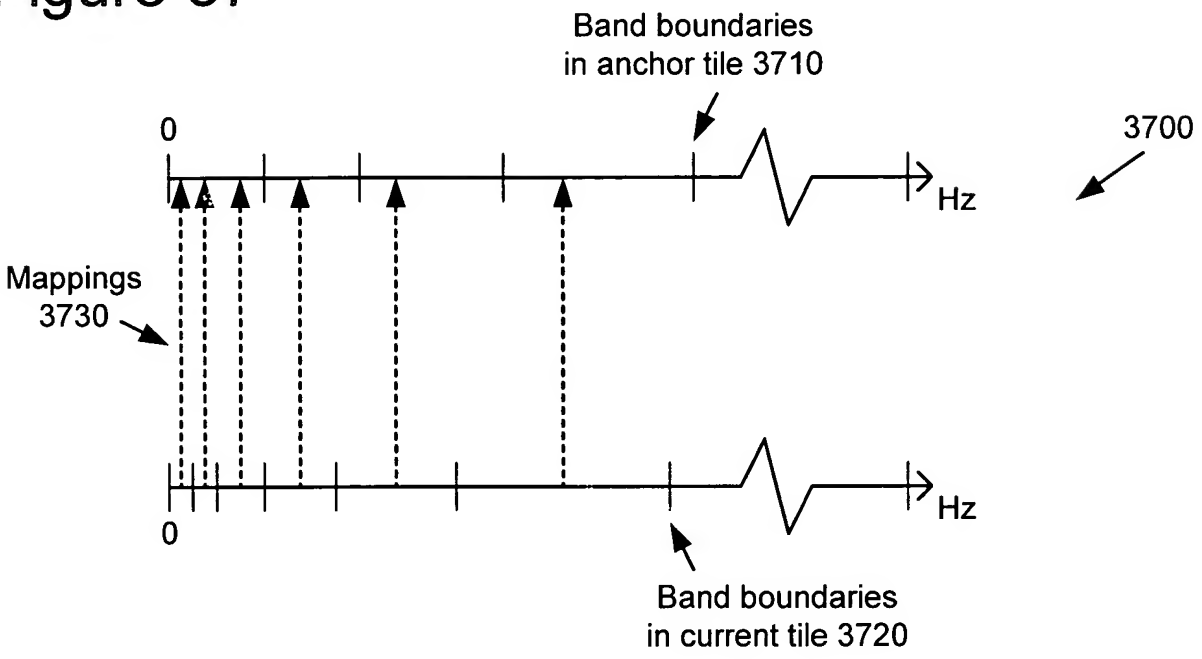

Figure 40

Post-processing transform matrix 4000

$$A_{P\text{-}Center} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 \\ 0.5 & 0.5 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix}$$

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Figure 38

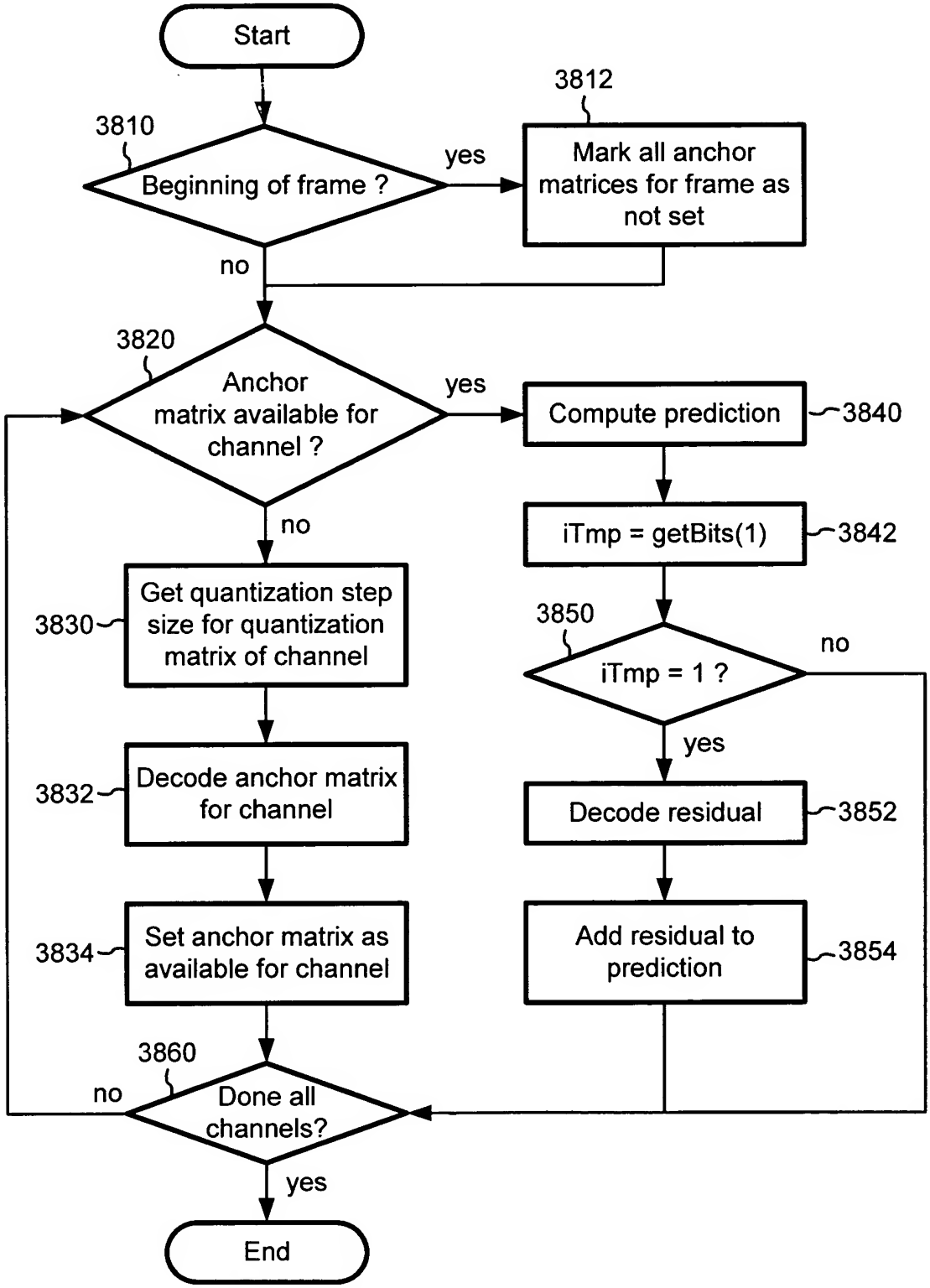

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Figure 41

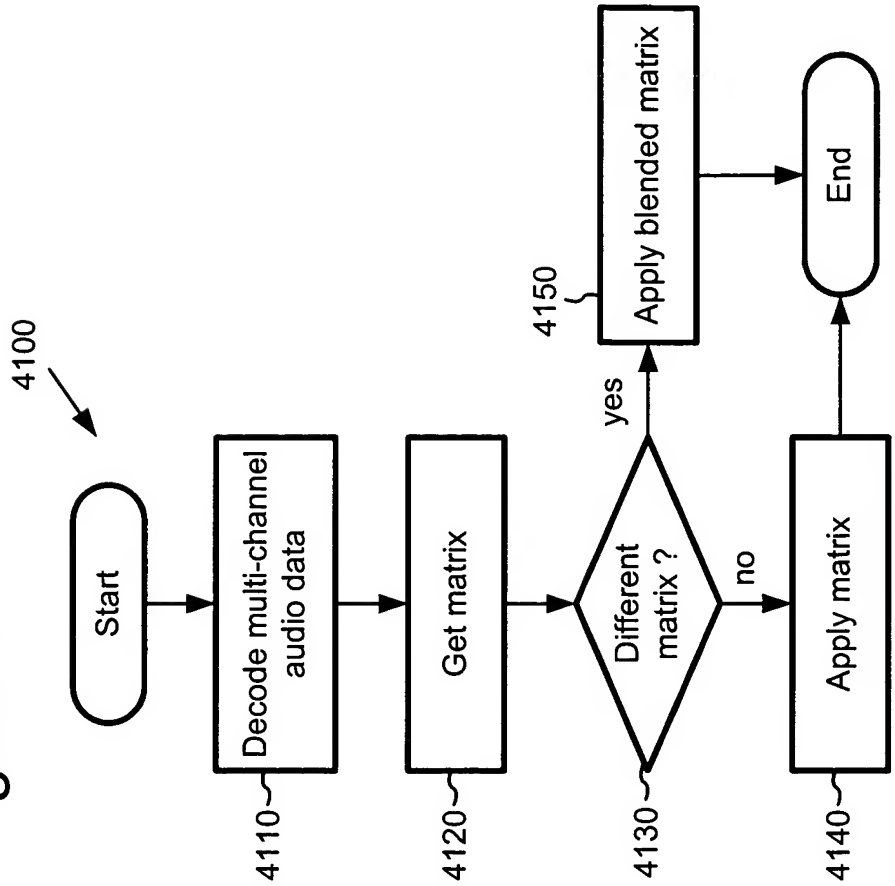
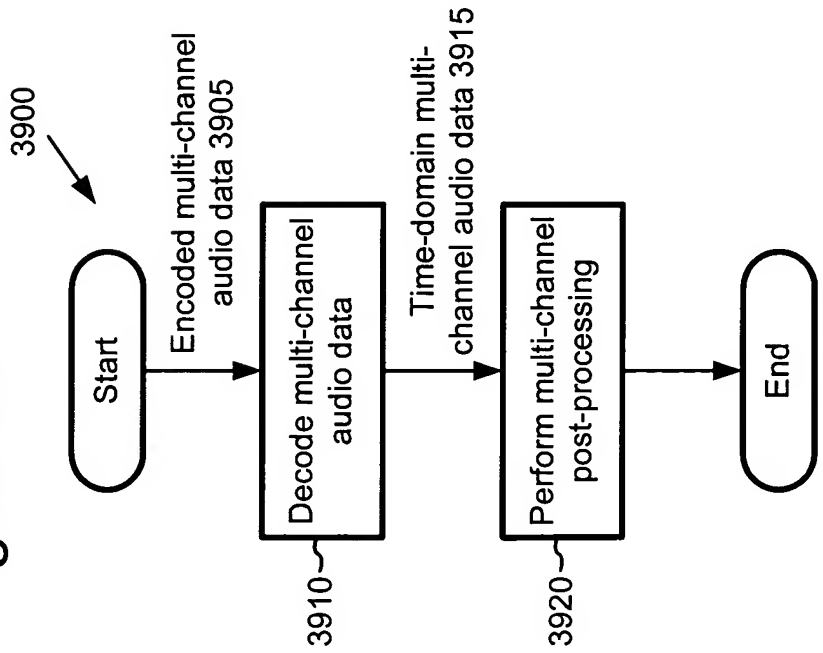


Figure 39



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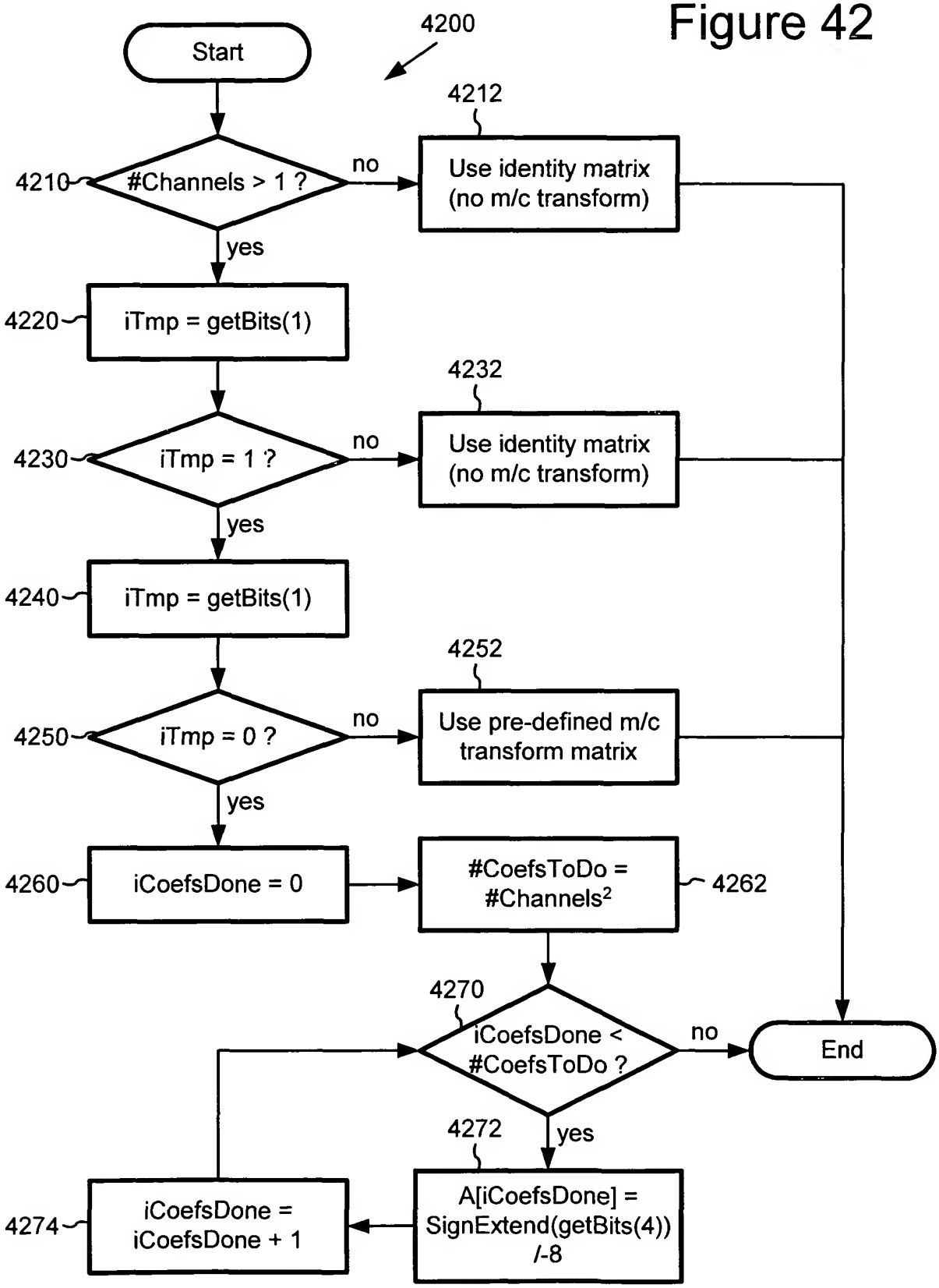
Figure 42